

# Emerging Technologies to Improve Accountability and Safeguards

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## Overview

- Nonproliferation Concerns/Safeguards Challenges
- Next Generation Safeguards Initiative
  - 5 Year Program
- Technology Assessment
- Stakeholders Meeting, April 2014

# Nonproliferation Concerns

- Approximately 20,000 cylinders are in active circulation at any time
  - Each cylinder can contain ~50 kg of  $^{235}\text{U}$  equivalent to 2 significant quantities (SQs) of Highly Enriched Uranium (HEU)
  - No single listing of all  $\text{UF}_6$  cylinders being used around the world
  - No industry-wide standard for uniquely identifying cylinders
- Not all Low Enriched Uranium (LEU) is under IAEA safeguards when produced & shipped
  - Nuclear Weapons State
- Enrichment capabilities (declared and clandestine) have increased in the last decade
- A small clandestine enrichment facility with a capacity of 10,000 – 25,000 SWU/year could convert:
  - Contents of a 48Y cylinder containing natural  $\text{UF}_6$  into an SQ of HEU in ~3 months – 1 year
  - Contents of a 30B cylinder containing LEU (~3-5% enriched) into an SQ of HEU in ~30-90 days

# International Safeguards Challenges

- Inspector time expended locating and identifying cylinders on-site
  - Resource intensive for inspectorates and the operator
- Inconsistent use of cylinder IDs across industry
  - Multiple site-specific IDs, plus cylinder pressure vessel IDs, multiple ID formats, multiple ID locations, making it difficult for an inspector to record the correct number
- Inconsistent application of cylinder IDs across industry
  - Increases likelihood of error in reading and recording IDs
  - Limits ability for IAEA to automate on-site inspection tasks and to efficiently match transfers
- Timely detection of diversion and facility misuse
  - Detecting diversion of a cylinder before a SQ of HEU can be produced
  - Detecting undeclared production pathways (using undeclared cylinders)

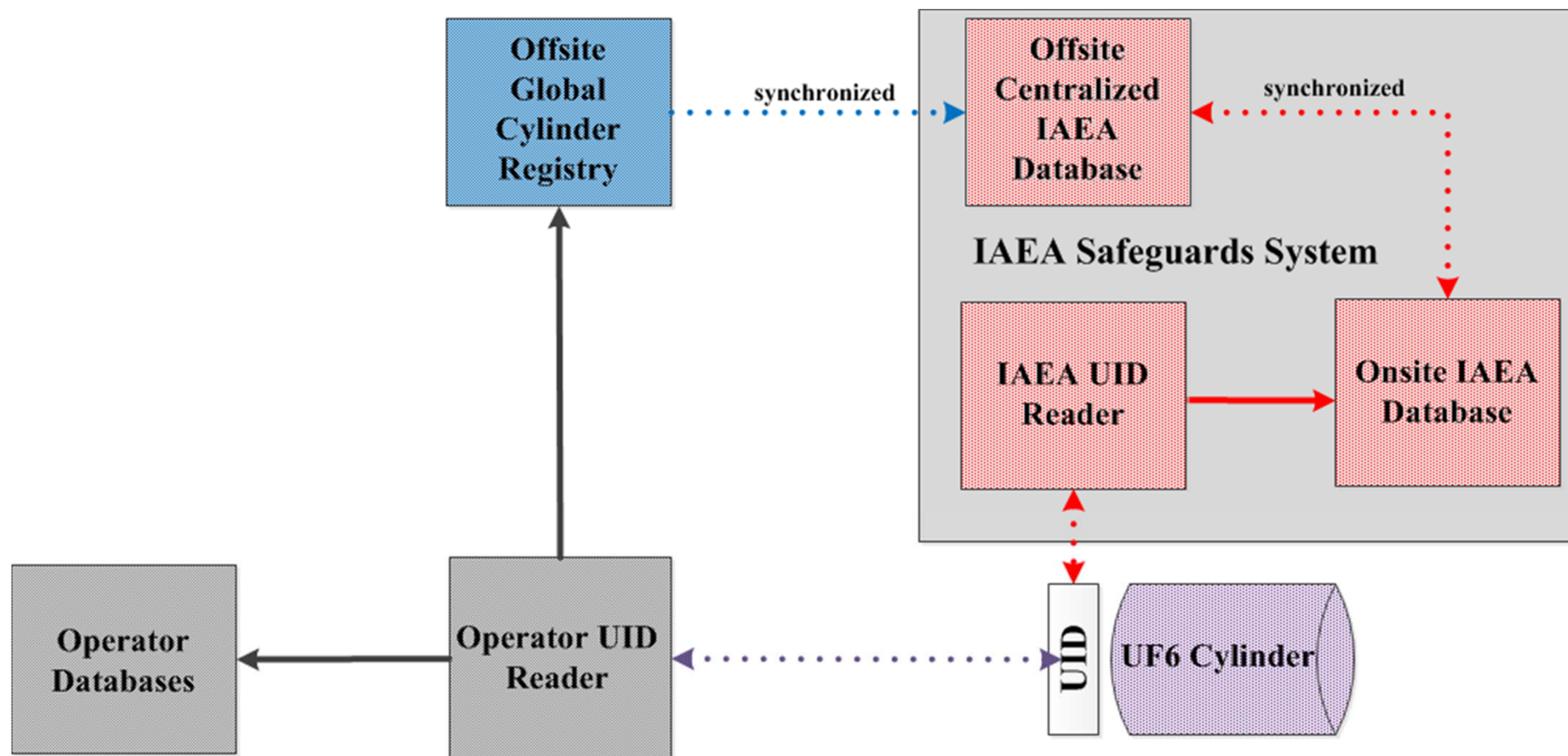


## NGSI UF<sub>6</sub> Cylinder Project Plan

- Multi-lab team kicked off 5-year project in April 2011
  - Define the challenges to be addressed before proposing solutions
  - Focus on COTS/GOTS technologies where possible
- **Project plan includes six tasks with “off-ramps” along the way**
  - Baseline problem definition - complete
  - Develop preliminary concept of operation for an identification & monitoring system - complete
  - **Determine technology requirements and identify available technologies**
    - in progress
  - **Develop preliminary cylinder registry concept – in progress**
  - **System integration**
  - **Demonstrate proof of concept of key components**



# Fundamental Components for the Proof of Concept



# Overlapping Benefits

## Operators

## Inspectorates

- Improved process controls
- Consistent paperwork & improved reporting
- Eliminates need for multiple markings

- Less confusion about multiple markings
- Fewer transcription errors
- Quicker/more efficient inventory
- Reduced radiation dose

- Higher confidence in identifying cylinders
- Improved capability to identify diversion or undeclared material
- Easier to reconcile transfers between countries

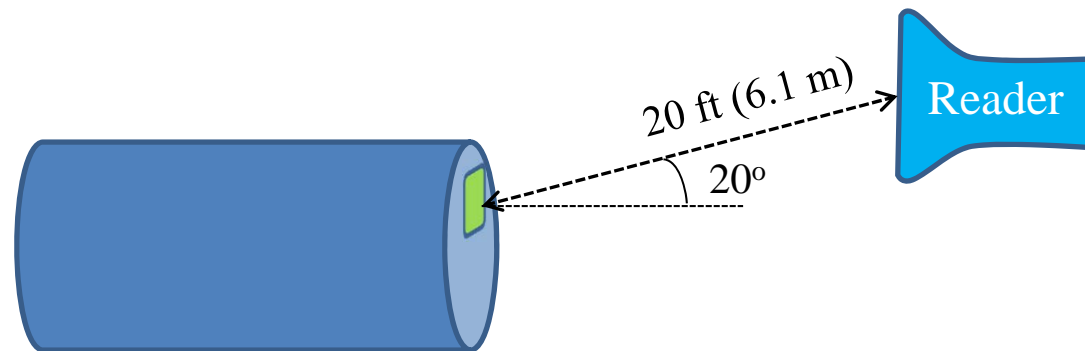
## Technology Assessment Results

- No current technology meets all requirements
- Hybrid approach
  - Two technologies offer everything but authentication
    - Bar codes
    - Radio frequency ID (RFID)
  - Facilities do not need authentication / tamper indication
  - Safeguards needs authentication / tamper indication
- Recommendation
  - Rugged bar codes + authentication measure





## Requirement Highlights



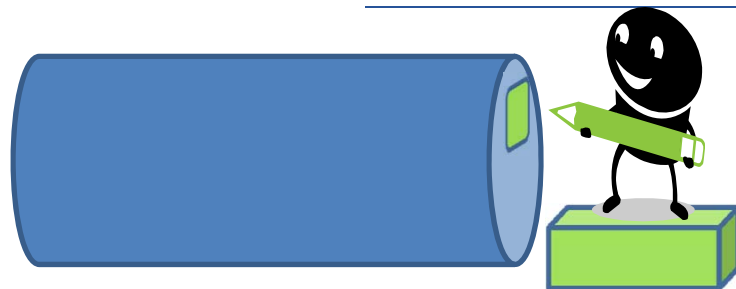
- Read ID from 1 ft (0.3 m) up to 20 ft (6.1 m) at up to 20° off normal
- Minimum 10 year design life
- Costs less than \$300 (US) per cylinder
- ID number readable without a reader unit (5 to 30 feet)
- Can be applied at cylinder fabricators, enrichment plants, and fuel facilities
- Application does not affect cylinder certification

## Requirement Highlights (cont.)



- Cylinder ID shall withstand external and operational environments
  - Normal weather for 10 Years
  - Functional from -25° F through 140° F
  - Withstand 100 cycles between -60° F and 250° F with 96 hrs at -60° F and 250° F
  - Indirect lightning effects
  - Withstand 50 ppm hydrogen fluoride at 90° F and 90% humidity for 96 hrs
  - Withstand shock of 1.2 m UF<sub>6</sub> cylinder drop
  - Functional when exposed to 50 mrem/hr radiation field for 30 days
  - Undamaged by or readily protected from cylinder painting, resurfacing, and cleaning that is performed at a nominal 5-year interval

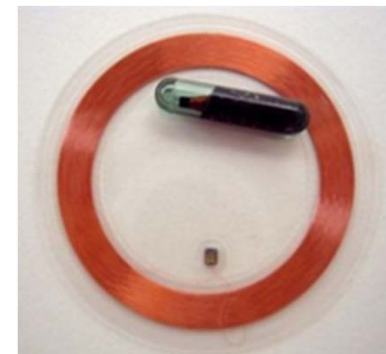
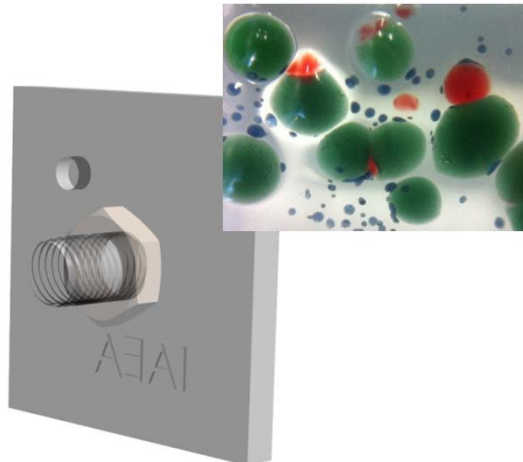
## Requirement Highlights (cont.)



- Tamper indicating / counterfeit resistant
- Operation shall not violate site safety / security Requirements
- Reader module size permits monitoring stations and readers
- Technology easy to use
- Accuracy and reliability of 99.9%

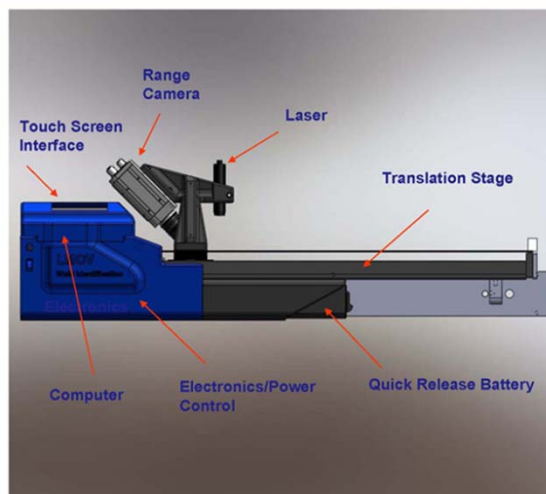
# Potential Authentication Technologies

- Discussions with the IAEA indicate that there are a number of technologies that merit closer consideration for authentication purposes, including:
  - Glass bead, secured with wire and verified by camera
  - Thin glass plates, epoxied and verified by camera
  - High frequency RFID, embedded



## Using Intrinsic Signature of a Weld

- The JRC developed the Laser Mapping for Container Verification (LMCV) to ensure cask lids have not been opened after welding.
- The IAEA will implement this technique in Canada to enhance cooperation and reduce efforts and costs.







# Stakeholder's Meeting: Background

**Meeting location and date: Washington DC, April 29-30**  
**~35 attendees**

- Industry
  - Areva
  - Cameco
  - EDF
  - INVAP
  - NAC International
  - Urenco
  - Worthington
- Regulators
  - CNSC
  - NRC
- DOE/NNSA
  - NNSA
    - Nonproliferation R&D
    - Nonproliferation & International Security
  - National Laboratory Staff
- Inspectorates
  - IAEA
    - Department of Safeguards-Operations C
    - Department of Safeguards-Technology and Systems
  - ABACC

## Topics of Discussion

- Nonproliferation concerns and challenges
- NNGSI preliminary concept of operations
- Existing industry cylinder ID monitoring requirements and practices
- Technology survey and assessment
- Future industry engagement
- Benefits for industry
- Global Cylinder Identification & Monitoring System's (GCIMS) registry concept

## Stakeholders Meeting: Meeting Objectives

- Pursue a shared understanding among stakeholders
  - Operational practices and regulatory considerations
  - Current industry initiatives
  - IAEA interest in project
  - Potential benefits of standardized UF<sub>6</sub> identification
- Solicit stakeholder feedback on NNSA efforts
  - Preliminary concept of operations
  - Technology requirements & assessment criteria
  - Technology assessment results
  - Preliminary registry concept
- Discuss path forward and future engagement

# Stakeholders Meeting: Meeting Outcome

- Pursue a shared understanding among stakeholders
  - IAEA and Industry are both interested in a system that could reduce inspector burden
- Solicit stakeholder feedback on NNSA efforts
  - Growing interest in a uniform format
  - Lingering questions regarding both the upfront and maintenance costs
- Currently no show stoppers associated with the concept expressed at the meeting
- Discuss path forward and future engagement
  - Facilitate industry discussion of how to best identify cylinders
    - Creation of Industry Working Group (potentially through WNTI's HEX working group)
  - Need to determine how to do authentication in a practical, cost-efficient manner
  - Continue close engagement of with industry and IAEA stakeholders to ensure that the requirements of all are met
  - Plans for the NNSA to hold a workshop with stakeholders following working group's initial meeting



# Thank You!!

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